Response to §112 Rejections

The Examiner rejected claims 46-55 under 35 USC §112, second paragraph, as indefinite, specifically citing an ambiguity regarding wettability of the barrier layers in claims 46-51 and antecedence for the zinc oxide in claims 52-55.

In response, applicant has amended claims 46 and 52. These claims find support at least in Figure 3 and the related text of the originally filed specification.

Accordingly, applicant respectfully requests that the Examiner reconsider and withdraw the §112 rejections.

Response to §102 Rejections

The Examiner rejected claims 56-59 and 62-73 and 76 under 35 USC § 102(b) as anticipated by Hirao (1197 Symposium on VLSI....), specifically reciting Hirao's Figures 1 and 6b.

In response, applicant submits that present claims distinguish from Hirao. Specifically, the relevant claims recite "a first diffusion-barrier layer having an in-portion within the trench or hole and an out-portion outside the trench or hole and on the first major surface."

In contrast, Hirao's Figure 1 shows a barrier layer (TiW, TiN, or Ti) completely within the trench and a SiN layer completely outside the trench. Thus, neither the barrier layer nor the SiN layer in Figure 1 have both an in-portion within the trench or hole and an out-portion on the first major surface as recited in the claim.

Hirao's Figure 6b, also in contrast to the relevant claims, shows a TiW barrier layer in a trench in an insulative layer, with a portion of the TiW barrier layer extending out of the trench beyond the top surface of the insulative layer, but not on the top surface. Figure 6b also shows a SiN layer on the top surface and abutting the extended portions of the TiW barrier layer.

Neither the TiW barrier layer nor the SiN layer have both an in-portion within the trench and an out-portion on the top surface of the first major surface as recited in the relevant claims. Although the TiW layer in this figure arguably has an in-portion and out-portion (the portion extending past the top surface of the insulative layer and out of the trench), the out-portion is not

"on the first surface" as the claims require. Moreover, there's no evidence in the record that one of skill would regard either Figure 1 or Figure 6b as teaching one to make a barrier layer having the required in-portion and out-portion.

In making the rejection, the Examiner appears to equate the portion of Hirao's "barrier formed 'on' a portion of the top surface which defines the bottom said trench" as the required out-portion that is both outside the trench and on the first major surface. However, it does not appear that one of ordinary skill would regard any barrier portion "which defines the bottom of a trench" as being outside the trench, when clearly any portion on the trench bottom is inside the trench. Indeed, there's no evidence in the record that one of skill would have regarded the bottom of a trench to be outside the trench. The fact is the only portions of Hirao's TiW barrier that are arguably outside the trench — the barrier sidewall portions extending past the top surface of the insulative layer--- are not on the top surface.

Additionally, applicant notes that the Examiner has put the term "on" in quotations marks throughout the text of the rejection, indicating his use of a special meaning of the term. Yet, the Examiner has cited no evidence that either the cited art or applicant applies anything other than an ordinary meaning to this term. Accordingly, applicant requests that the Examiner not only fully clarify his special treatment of the term, but also produce evidence to justify his special treatment of the term "on" in the present claims.

Also, the Examiner cites that Hirao's Figure 6a reads on the rejected claims, asserting that "inherently materials are comprised of multiple contiguous layers." However, the record is devoid of any evidence that one of skill in the art would regard Hirao's Figure 6a as teaching more than one barrier layer. Construing Hirao's single barrier layer as teaching multiple layers would appear to conflict with the ordinary and plain meaning of the term "layer." The MPEP requires claim terms to be given their ordinary meaning, unless otherwise indicated in the application. Thus, applicant requests that the Examiner substantiate that the relevant art defines "layer" according to the asserted definition and that such definition is in effect in the given application.

Moreover, even if one accepted the Examiner's definition for layer, it still does not appear that one of skill in the art would regard Figure 6a as teaching the combination of a first barrier layer having the required in-portion and out-portion and a second barrier layer having "no substantial portion within a trench or hole" as the relevant claims require. Indeed, it would appear that all the "inherent" layers in Hirao's Figure 6a would have a portion within the trench.

Accordingly, applicant respectfully requests that the Examiner reconsider and withdraw the §102 rejections.

Conclusion

In view of the amended claims and these remarks, applicant respectfully requests reconsideration and withdrawal of the rejections. Moreover, applicant invites the Examiner to telephone its patent counsel Eduardo Drake (612 349-9593) to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

KIE Y. AHN ET AL.

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Date 8 July 2002 By _____
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CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to: Box AF, Commissioner of Patents, Washington, D.C. 20231, on this 8th day of July, 2002.

Name Amy Moriarty Signature _____

Docket No. 303.458US2
WD #408236

Micron Ref. No. 97-0853.01

Clean Version of Pending Claims

METHODS FOR MAKING COPPER AND OTHER METAL INTERCONNECTIONS IN INTEGRATED CIRCUITS
Applicant: Kie Y. Ahn et al.
Serial No.: 09/817,447

Claims 38-76, as of July 8, 2002 (date of response to final office action filed).

38. An integrated-circuit assembly comprising:

an insulative layer having a trench or hole, the trench or hole having an edge;

a first diffusion barrier having a portion inside the trench or hole; and

a second diffusion barrier on the insulative layer and having an edge substantially flush with a least a portion of the edge of the trench or hole, with the second diffusion barrier comprising a zinc oxide material and the first diffusion barrier comprising a material different than the zinc oxide material.

39. The integrated-circuit assembly of claim 38:

wherein the assembly further comprises a metal within the trench or hole; and

wherein the first diffusion barrier has a first wettability with the metal and the second diffusion barrier has a second wettability with the metal, the first wettability greater than the second wettability.

40. The integrated-circuit assembly of claim 38, further comprising a copper structure within the trench or hole.

41. The integrated-circuit assembly of claim 38, wherein the first diffusion barrier consists essentially of tungsten, titanium-tungsten, or titanium nitride.

42. The integrated-circuit assembly of claim 38, wherein the second diffusion barrier has no substantial portion within the trench or hole.

43. The integrated-circuit assembly of claim 38, wherein the trench or hole has an outer perimeter and wherein the second diffusion barrier includes a portion extending over the outer perimeter of the trench or hole.

44. The integrated-circuit assembly of claim 38, wherein the portion of the first diffusion barrier conforms to walls and a floor of the trench or hole.

45. The integrated-circuit assembly of claim 38, wherein the insulative layer consists essentially of a silicon oxide.

46. (Amended) An integrated-circuit assembly comprising:

an insulative layer having opposing first and second major surface, with the first major surface having a trench or hole, the trench or hole having an edge;

a first diffusion barrier having an in-portion lining the trench or hole and having an out-portion outside the trench or hole and on the first major surface, with the out-portion having an edge adjacent the edge of the trench or hole;

a second diffusion barrier on the out-portion of the first diffusion barrier and having an edge substantially flush with a least a portion of the edge of the first diffusion barrier, with the second diffusion barrier comprising a zinc oxide material;

a copper conductor within the trench or hole and on the first diffusion barrier, with the second diffusion barrier having lesser wettability with copper than the first diffusion barrier.

47. The integrated-circuit assembly of claim 46, wherein the second diffusion barrier has no substantial portion within the trench or hole.

48. The integrated-circuit assembly of claim 46, wherein the insulative layer consists essentially of a silicon oxide.

49. The integrated-circuit assembly of claim 46, wherein the first diffusion barrier consists essentially of tungsten.

50. The integrated-circuit assembly of claim 46, wherein the first diffusion barrier consists essentially of titanium-tungsten.

51. The integrated-circuit assembly of claim 46, wherein the first diffusion barrier consists essentially of titanium nitride.

52. (Amended) An integrated-circuit assembly comprising:

an insulative layer having opposing first and second major surface, with the first major surface having a trench or hole, the trench or hole having an edge;

a first diffusion barrier having an in-portion lining the trench or hole and having an out-portion outside the trench or hole and on the first major surface, with the out-portion having an edge adjacent the edge of the trench or hole, the first diffusion barrier consisting essentially of tungsten, titanium-tungsten, or titanium nitride;

a second diffusion barrier on the out-portion of the first diffusion barrier and having an edge substantially flush with a least a portion of the edge of the first diffusion barrier;

a copper conductor within the trench or hole and on the first diffusion barrier, with the second diffusion barrier having lesser wettabillity with copper than the first diffusion barrier.

53. The integrated-circuit assembly of claim 52, wherein the second diffusion barrier consists essentially of zinc oxide.

54. The integrated-circuit assembly of claim 52, wherein the second diffusion barrier has no substantial portion within the trench or hole.

55. The integrated-circuit assembly of claim 52, wherein the insulative layer consists essentially of a silicon oxide.

56. An integrated-circuit assembly comprising:

an insulative layer having opposing first and second major surfaces and a trench or hole in the first major surface;

a first diffusion-barrier layer having an in-portion within the trench or hole and an out-portion outside the trench or hole and on the first major surface; and

a second diffusion-barrier layer on the out-portion of the first diffusion-barrier layer, the second diffusion-barrier layer having no substantial portion within the trench or hole.

57. The integrated-circuit assembly of claim 56, wherein the trench or hole has an outer perimeter at the first major surface and wherein the second diffusion-barrier layer includes a portion extending over the outer perimeter of the trench or hole.

58. The integrated-circuit assembly of claim 56, wherein the first diffusion-barrier layer has a first wettability with a metal and the second diffusion-barrier layer has a second wettabillity with the metal, the first wettability greater than the second wettability.

59. The integrated-circuit assembly of claim 56, wherein the first diffusion-barrier layer consists essentially of a material having a first wettability with a metal, and the second diffusion-barrier layer consists essentially of a material having a second wettability with the metal, with the first wettability greater than the second wettability.

60. The integrated-circuit assembly of claim 56, wherein the first diffusion-barrier layer consists essentially of a zinc oxide material and the second diffusion barrier consists essentially of tungsten, titanium-tungsten, or titanium nitride.

61. The integrated-circuit assembly of claim 56, wherein the first diffusion-barrier layer consists essentially of a zinc oxide material.

62. The integrated-circuit assembly of claim 56, wherein the second diffusion barrier consists essentially of tungsten, titanium-tungsten, or titanium nitride.

63. The integrated-circuit assembly of claim 56, further comprising a copper structure within the trench or hole.

64. The integrated-circuit assembly of claim 56, wherein the insulative layer consists essentially of a silicon oxide.

65. The integrated-circuit assembly of claim 56, wherein the in-portion of the first diffusion-barrier layer conforms to walls and a floor of the trench or hole.

66. An integrated-circuit assembly comprising:

a silicon oxide insulative layer having opposing first and second major surfaces and a trench or hole in the first major surface;

a first diffusion-barrier layer having an in-portion within the trench or hole and an out-portion outside the trench or hole and on the first major surface;

a second diffusion-barrier layer on the out-portion of the first diffusion-barrier layer, the second diffusion-barrier layer having no substantial portion within the trench or hole; and

a copper conductor at least partially within the trench or hole and on the first diffusion-barrier layer.

67. The integrated-circuit assembly of claim 66, wherein the in-portion of the first diffusion-barrier layer conforms to walls and a floor of the trench or hole.

68. An integrated-circuit assembly comprising:

an insulative layer having opposing first and second major surfaces and a trench or hole in the first major surface;

a first diffusion-barrier layer having an in-portion within the trench or hole and an out-portion outside the trench or hole and on the first major surface, the in-portion of the first diffusion-barrier layer conforming to walls and a floor of the trench or hole;

a second diffusion-barrier layer on the out-portion of the first diffusion-barrier layer, the second diffusion-barrier layer having no substantial portion within the trench or hole; and

a copper conductor at least partially within the trench or hole and on the first diffusion-barrier layer.

69. The integrated-circuit assembly of claim 68, wherein the insulative layer consists essentially of silicon oxide.

70. An integrated-circuit assembly comprising:

an insulative layer having opposing first and second major surfaces and a trench or hole in the first major surface, with the trench or hole having an outer perimeter;

a first diffusion-barrier layer having an in-portion within the trench or hole and an out-portion outside the trench or hole and on the first major surface, the in-portion of the first diffusion-barrier layer conforming to walls and a floor of the trench or hole;

a second diffusion-barrier layer on the out-portion of the first diffusion-barrier layer, the second diffusion-barrier layer having no substantial portion within the trench or hole and having a portion extending over the outer perimeter of the trench or hole; and

a copper conductor at least partially within the trench or hole and on the first diffusion-barrier layer.

71. The integrated-circuit assembly of claim 70, wherein the insulative layer consists essentially of silicon oxide.

72. An integrated-circuit assembly comprising:

an insulative layer having opposing first and second major surfaces and a trench or hole in the first major surface, with the trench or hole having an outer perimeter;

a first diffusion-barrier layer having an in-portion within the trench or hole and an out-portion outside the trench or hole and on the first major surface and

consisting essentially of a material having a first wettability with a metal, with the in-portion of the first diffusion-barrier layer conforming to walls and a floor of the trench or hole;

a second diffusion-barrier layer contacting the out-portion of the first diffusion-barrier layer, consisting essentially of a material having a second wettabillity with the metal, having no substantial portion within the trench or hole, and having a portion extending over the outer perimeter of the trench or hole, with the second wettability less than the first wettability; and

a conductor consisting essentially of the metal and being at least partially within the trench or hole and on the first diffusion-barrier layer.

73. The integrated-circuit assembly of claim 72, wherein the insulative layer consists essentially of silicon oxide.

74. The integrated-circuit assembly of claim 72, wherein the first diffusion-barrier layer consists essentially of a zinc oxide material and the second diffusion barrier consists essentially of tungsten, titanium-tungsten, or titanium nitride.

75. The integrated-circuit assembly of claim 72, wherein the first diffusion-barrier layer consists essentially of a zinc oxide material.

76. The integrated-circuit assembly of claim 72, wherein the metal consist essentially of copper.